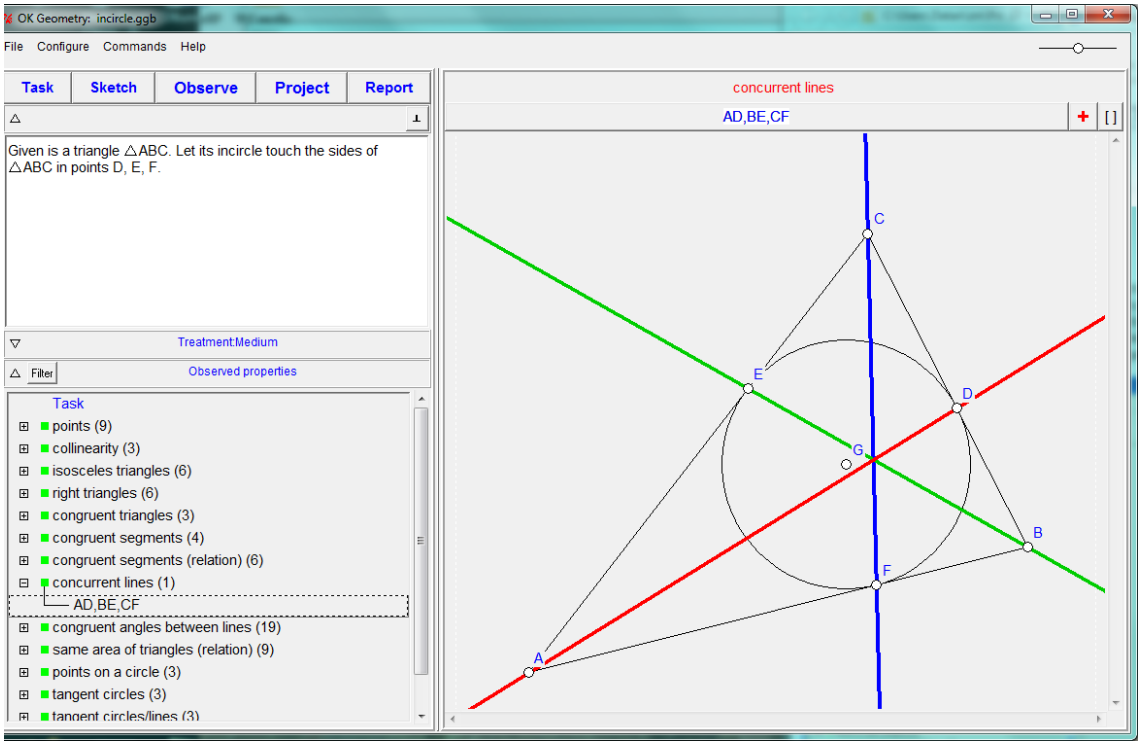
What is OK Geometry ?

Zlatan Magajna

1 What is OK Geometry ?

OK Geometry is an aid for analysing geometric constructions. Given a dynamic geometric construction OK Geometry detects patterns as well as certain properties of the construction. You may think of OK Geometry as a pair of geometric spectacles for observing invariants of geometric constructions. With OK Geometry students notice properties they may not be aware of. Detecting properties is, among other, an important step in proving facts. OK Geometry may also help in organising the found information.



2 OK Geometry, for whom?

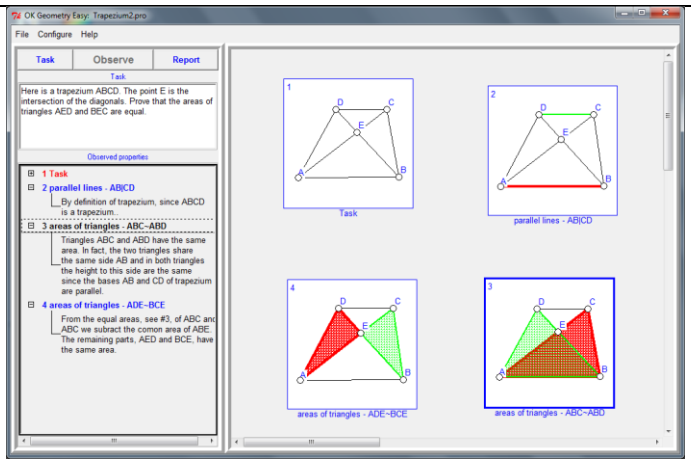
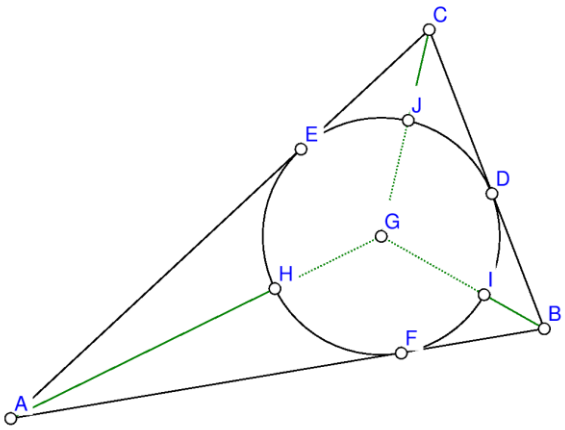
OK Geometry works in three modes.

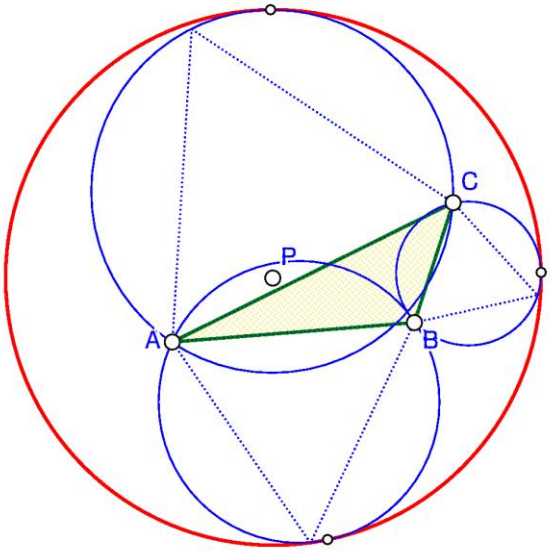
The **Easy mode** is intended for occasional users and for students who are learning the concept of deductive proof in geometry context.

The **Basic mode** is intended for teachers and students who like to investigate challenging problems in plane geometry.

The **Plus mode** is aimed at enthusiast and specialists in the field of plane geometry.

3 What can OK Geometry do?

For students who are learning to prove geometric facts OK Geometry may be an environment for solving prepared proving tasks. The prepared task typically contains selected properties that need to be properly ordered, provided with deductive arguments and structured into a proof.	
To occasional users who use some dynamic geometry software OK Geometry helps in detecting properties of dynamic constructions (imported from other programs). For example, in the construction on the right OK Geometry detects, among other, that H is the orthocentre of the triangle AEF, that the lines AD, BE, and CF concur in a point, say U, that the lines HD,FE, and JF concur as well in a point, say V. Ok Geometry Plus reveals that U is the Gergonne point and V is the so-called mid-arc point of the triangle ABC, that on the line UV lays also the Kimberling point X(555), and many other properties.	

Enthusiast students and teachers may use OK Geometry as an aid in solving problems and proving facts in plane geometry. OK Geometry produces hypotheses about the relations in geometric configurations, about solution of optimisation problems, about implicit constructions. The generated hypotheses may be of interest by themselves or may help in making up deductive proofs. Consider, for example, a triangle ABC. On each of its sides construct an equilateral triangle and its circumcircle. Consider the circle that touches these three circles and contains them. OK Geometry observes that the centre P of this circle is the intersection of lines (X_{10},X_{13}) and (X_1,X_{3411}) where X_n denotes the n-th Kimberling centre. In fact, in observing triangles OK Geometry uses a rich base of triangle centres (10000 of them), triangle characteristic circles, lines, conics and variaous triangle related transformations.	

More examples can be found in the documentation files, in particular at the end of the OK Geometry Editor documentation.

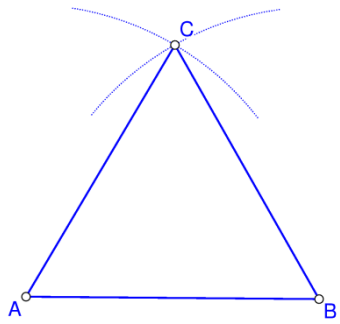
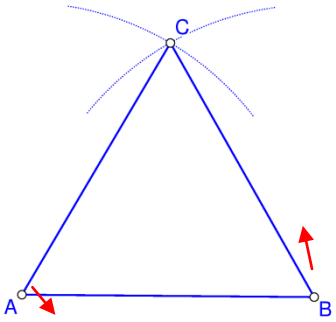
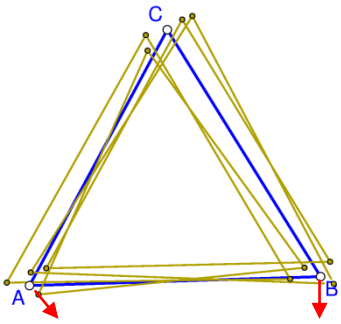
4 What does OK stand for in OK Geometry?

OK is an acronym for Observing and Knowing Geometry. OK Geometry helps in observation (it is very good in detecting properties), but students should be aware that one thing is to **observe** something, another thing is to **know that** something is true, and still another is to **know why** something is true. OK Geometry helps in observing and may help to find out and understand why something is true. OK Geometry does not prove facts.

5 How does OK Geometry detect properties?

The model behind Geometry is the ***stochastic dynamic model.*** This model is similar to the dynamic model in the sense that the non-constructed (free) objects can be moved around while the constructed objects are modified according to the construction procedure. However, in the stochastic dynamic

model the non-constructed objects are represented by several copies of randomly positioned objects. The constructed objects are represented by several objects constructed from copies of other objects in accordance with the construction. Only one copy of each object is visible, and assumes a reasonably random position (as well as its copies).

		
The static model. All represented objects are fixed.	The dynamic model. The free (non-constructed) points can be dragged. All other objects change accordingly.	The stochastic dynamic model. Free (non-constructed) points are represented by several copies of randomly positioned points and can be visually dragged. There are several randomly positioned copies of each object – only one of them is visible.

In simple terms, OK Geometry reads dynamic constructions (not positions). The program then makes several copies of the construction by randomly moving all free points. The properties that are invariant (in terms of measurement) to such perturbations are considered to be 'observed'. But not proved, of course.

6 How OK Geometry helps in proving geometric facts?

A big obstacle in proving geometric facts is that the solver is not aware of facts that could be considered in making up the proof. OK Geometry does not prove facts, it only detects many relations that are true with highly probability. It is up to the user (or to the teacher, if s/he prepares tasks) to select which properties are relevant in particular situations and how to compose them into a deductive argumentation. Selecting relevant properties may be difficult for the inexperienced solvers but highly rewarding for the experienced ones.

7 How to obtain dynamic constructions to be analysed?

OK Geometry can read dynamic constructions made with some of the widespread programs of dynamic geometry (Cabri Geometre, Cabri Express, GeoGebra, Cinderella, Z.u.L (Zirkel und Linien)., JGEX, Sketchometry). For non-occasional users of OK Geometry the easiest way to make constructions is to make them directly in OK Geometry using the OK Geometry Editor.

8 How does OK Geometry Editor differ from dynamic software programs?

The main difference is the aim itself. Dynamic geometry software stresses conceptual understanding and various visualisation methods. On the other hand the aim of OK Geometry Editor is designed to produce dynamic constructions to be analysed and understood. Thus great emphasis is put on effectiveness: shapes (e.g. a kite) and certain non-trivial constructions (e.g. a circle tangent to three other circles) can be constructed on the fly in order to enable the analysis. It is also possible to do implicit constructions, i.e. automatically modify a construction so that some additional properties are satisfied.

9 Who is the author of OK Geometry?

The author of OK Geometry is dr. Zlatan Magajna. He is a lecturer in didactics of mathematics at the Faculty of Education, University of Ljubljana, Slovenia.

Magajna, Z. (2011) An observation tool as an aid for building proofs. *The electronic journal of mathematics & technology.* 5(3). 251-260. *Available at* https://php.radford.edu/~ejmt/.

Magajna, Z. (2013) Overcoming the Obstacle of Poor Knowledge in Proving Geometry Tasks. *CEPS Journal* . 3 (4). 99-116. *Available here*.

Magajna, Z. (2017) Automated Observation of Dynamic Constructions. *International Journal for Technology in Mathematics Education* . Vol. 24 Issue 3, p115-120. Available at http://www.researchinformation.co.uk/timearch/2017-03/pageflip.html